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(71)(72) Applicant and Inventor: HALL, Brett [US/US]; 4206 Lazy Creek Drive, Marietta, GA 30066 (US).



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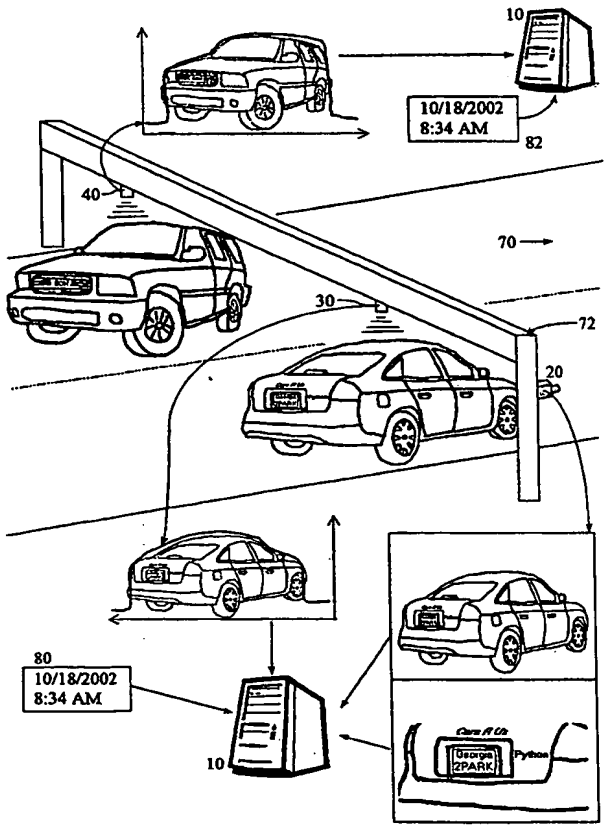
(54) Title: COMPUTERIZED PARKING FACILITY MANAGEMENT SYSTEM


(57) Abstract

The computerized parking facility management system (10) provides management for parking garages, parking lots, street parking, as well as no charge–for–parking operations. As each vehicle enters the parking facility (70) photographs of the vehicle and its license plate uniquely identify it. Additional identities include characterizing the vehicle's contour to determine its parking location. An alternate embodiment implements the Global Positioning System (GPS) to determine parking location. Variable message displays provide ongoing information to motorists of available parking spaces. The system is able to identify the specific vehicle parked in any parking spaces. The system also allows computer searching of the vehicles within the parking facility according to various search criteria. The system can provide automatic notification of a vehicle's presence or absence based on parking occupancy or time. A vehicle theft deterrent system can provide protection to any vehicle parked within the facility.

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# COMPUTERIZED PARKING FACILITY MANAGEMENT SYSTEM

## TECHNICAL FIELD

The present invention relates to a computerized parking facility management and control system.

## BACKGROUND ART

During the last several years, the application of computer technology has had a tremendous impact on our lives. The use of items such as personal computers, hand-held personal organizers and computerized automotive controls are a few of the many examples how computer technology can be applied to a daily situation, and make that situation easier and more efficient to manage. With the rapidly expanding use of the Internet, the implementation of computer technology into our daily lives will no doubt continue.

Rudimentary computerized control and management of parking facilities is known in related art. Several basic functions such as imputing the time a customer arrives and departs a given parking facility and applying an established rate and fee are commonplace today. These basic capabilities are outlined in the patents issued to Mahmood, U.S. Pat. No. 5,091,727, Anthonyson, U.S. Pat. 5,414,624 and Matsuyama et al. 5,745,052.

Attempts have been made at expanding the scope of these capabilities, such as having the parking facility system assist a customer in finding a vacant parking space. This feature is described in the patent issued to Mahmood, U.S. Pat. No. 5,091,727, but only indicates vacant parking spaces closest to the entrance or exit of a parking facility, not the closest vacant parking space from any point within the parking facility. Mahmood's determination of parking vacancies is based solely on theoretical inventory in a database and not the actual spaces in the parking facility.

Basic vehicle theft deterrence from parking areas has been incorporated into computerized parking facility management systems, as described in the patent issued to Gerber, U.S. Pat. No. 5,638,302. However, the Gerber system is dependent on ticket distribution, only provides vehicle theft deterrence and does not address other issues of parking facility management.

The patent issued to Moore, U.S. Pat. No. 5,845,268, discloses a computerized parking facility management system using electronic-based parking meters that help to apprehend parking violators. The patent to Moore also outlines a method for detecting vacant parking spaces and monitors the movement of vehicles coming into and going out of a parking space. The Moore system is only applicable to identifying violators in park-for-charge facilities that use parking meters. All other related art is significantly dependent on human intervention for proper operation.

Despite the tremendous advances in computer technology, the advances in parking facility management have not kept pace. To prove this, one only need to try to find parking at a crowded retail business, large public events, airports or busy downtown areas. In fact, motorists spend more time than ever looking for parking vacancies. Furthermore, parking facility managers are still largely unaware of the dynamics of their facilities such as the arrival and departure of specific vehicles, their

parking location, physical identities and which specific spaces are open or occupied at any time.

Even the occurrence of a vehicle theft is often unknown until after the vehicle has been removed from the parking facility. The value of the real-time information provided by this invention is applicable to increased security, improved customer service as well as better planning and management of a parking facility. This invention provides the stated information and capabilities to not only enhance the management of parking facilities but also to allow that management to be reflective of today's technology advances in other areas of our lives. None of the above inventions and patents, taken either singularly or in combination, is seen to describe the instant invention as claimed. Thus a parking facility management system solving the aforementioned problems is desired.

## DISCLOSURE OF INVENTION

As more vehicles are manufactured and purchased each year and combined with the numbers of existing vehicles it is obvious that parking is and will continue to be a public issue. With the rapid and continuing growth of cities and suburban areas has come a growth in traffic and a need to provide improved parking for business patrons at malls and shopping areas, airports, employees, downtown areas, and large public events. However, providing improved parking does not always demand the construction of more parking spaces but instead may only require better management of existing spaces. This invention seeks to accomplish that purpose and is applicable to parking garages, parking lots, street parking, as well as no-charge and charge-for-parking operations. Prior art has not addressed these varieties of parking operations.

Managers and operators of large parking facilities have a limited knowledge of their parking occupancies and vacancies, when they occur, and where they are. The capacity percentage of their facility is mostly a mystery unless it is nearly empty or nearly full. An object of this invention is to deliver improved management of parking facilities by not only allowing the rapid and continuous determination of the number of available parking spaces but their exact location as well. It is also an object of this invention to reveal the identity of the specific vehicle parked in any space. These accomplishments are primarily done through methods and devices to track the vehicle's location such as capturing the unique features of each vehicle upon entry into the parking facility and comparing those features when the vehicle parks. The vehicle characterization includes the use of sensors to capture the vehicle's contour and digital cameras to photograph the vehicle and its license plate. The conversion of the license photograph to computer-recognizable text allows the system to computer process the license to provide features such as the determination of the vehicle's parked location by using the license as search criteria.

Parking facility operators are provided a comprehensive and flexible System Interface for the viewing of parking dynamics and the control of various system functions. The System Interface is viewable on a computer screen and serves as a simulation of the parking facility activities by duplicating the real-time parking occupancies and vacancies occurring within the parking facility. The interface also provides the visual identities of the vehicles parked in any space and includes statistics

regarding the time and date of vehicle entry into the facility and the parking space. Also provided are a-means to capture, display, store, organize, retrieve and document the parking activities and vehicle identities of any vehicle that parks in the facility. Internet, fax and e-mail capabilities are a part of the system to support the transmission of parking facility activities and vehicle identities. The capability to instantly see the status of an entire parking facility through a single information source surpasses prior art.

The availability of parking spaces within the facility is communicated to motorists through variable message displays. As sensors determine the presence or absence of vehicle within parking spaces the displays are continuously updated to reflect the actual parking availability. The system further conveniences motorists by providing a vehicle theft deterrent system which activates alarms and barriers to restrict removal of the vehicle from the facility as well as automatically notifying police, local security, the vehicle owner and other key persons upon an attempted unauthorized removal of a vehicle. Thus the system intends to not only make finding available parking faster and easier but also heighten security.

This system intends to provide continuous inventory of all vehicles within the parking facility. Thus integration with standard parking revenue control efforts will alleviate the need for the manual and costly inventory conducted with parking revenue control operations. These and other objects of the present invention will become readily apparent upon further review of the following specification and drawings.

## BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 shows the entrance of the computerized parking facility management system and the capturing of vehicle contour and visual identities.

Fig. 2 is a view of a parking facility utilizing the computerized parking facility management system to locate vacant parking spaces for motorists.

Fig. 3 is a view of the parking status data acquisition from a parking section and the System Interface's graphical parking replica displaying that parking status.

Fig. 4 is a view of the System Interface's graphical parking replica for a parking section and the Vehicle Identification function identifying the vehicle in a parking space.

Fig. 5 is a view of the System Interface computer screen displaying the Search function of the computerized parking facility management system.

Fig. 6 is a view of the System Interface's graphical parking replica for a parking section and the Notification function that allows the monitoring of a vehicle or a parking space.

Fig. 7 shows a change in the status of a parking space and the subsequent notification on the System Interface computer screen.

Fig. 8 shows a vehicle entering the parking facility and being registered for theft prevention by the capture of the vehicle's contour and photographs and the transfer of the Theft Prevention Profile into the computerized parking facility management system.

Figure 9 is a view of the vehicle theft prevention actions invoked by the parking facility management system in response to an attempt to steal a vehicle.

Fig. 10 shows the System Interface providing a theft in progress notification from the Theft Prevention function in response to an attempt to steal a vehicle.

Fig. 11 is a view of the computerized parking facility management system for street parking implementations.

Fig. 12 is a second embodiment integrating global positioning system technology with the computerized parking facility management system.

Similar reference characters denote corresponding features consistently throughout the attached drawings.

## BEST MODES FOR CARRYING OUT THE INVENTION

The present invention is the computerized parking facility management system. This invention provides improved management of parking facilities through rapid identification of vehicles, the identification and notification of available parking spaces, notification of the changes in the status of parking spaces, and theft deterrence of vehicles parked in the parking facility. All information and control is provided through a single System Interface. Executing these functions begins with characterizing each vehicle as it enters the parking facility 70 as shown in Fig. 1.

The first attribute of a vehicle is the capture of the vehicle contour as that vehicle enters the parking facility 70. The present choice of technology to perform this is ultrasonic. An ultrasonic sensor 30 mounted over the parking facility entrance 72 scans the vehicle as it passes. The change in the distance from the ultrasonic sensor 30 to target surfaces of the vehicle defines the vehicle contour. The dimensions of different vehicles will produce different vehicle contours as shown in Fig. 1.

As explained later, vehicle contour identification is used to determine where each vehicle is parked. An expanded form of vehicle identification is obtained by comparing the vehicle contour to a database of known contours to determine the manufacturer and model of the vehicle. After capturing the vehicle contour, the entry ultrasonic sensor 30 triggers a digital camera 20 and notifies the computerized parking facility management system that another vehicle has entered the parking facility 70.

Visual vehicle identities are captured with the digital camera 20. As also shown in Fig. 1, the digital camera 20 records the vehicle's manufacturer, model, color and license plate. The digital camera 20 and entry ultrasonic sensor 30 information are combined with the date and time 80 of the vehicle's entry into the parking facility 70 and stored in the system computer 10. The date and time 80 of the entry into the parking facility 70 is the first vehicle statistic. The specific parking location along with the date and time of parking establish another vehicle statistic. Yet another vehicle statistic occurs when a vehicle leaves the parking facility 70 and the departing exit date and time 82 are recorded. Fig. 1 shows that another ultrasonic sensor 40 at the exit can be used to capture the vehicle contour as a vehicle exits the parking facility 70. This is the conclusive action that will confirm the exit and complete the vehicle statistics for the target vehicle.

The Vehicle Profile is the characteristics and information that uniquely defines the vehicle. Examples include the contour, photographs, license tag, manufacturer, model, color, owner, insurance agent, and (if applicable) the company for activating and tracking the transmitter within the vehicle if stolen. The variable components of the vehicle statistics are the dates and times of a vehicle's entry into and exit from the parking facility and the parking space. This information also includes the vehicle's parking location, revenue charged, and whether it is being monitored for theft prevention. The constant components of the vehicle statistics are largely defined by the Vehicle Profile. Generally, vehicle statistics are the documentation of the vehicle's presence and activities while within the parking facility as well as the information displayed and required to support a particular function of the computerized parking facility management system. When a vehicle exits the parking facility all

information associated with the vehicle will be deleted from the system unless a parking facility operator previously requested that this information be archived.

Fig. 2 illustrates the typical dynamics of a parking facility 70, with vehicles coming and going at random times and motorists looking for the space closest to the entrance of their destination. Fig. 2 also shows sensors 60 mounted over each parking space. The parking sensors 60 are of the same ultrasonic technology as the entry sensor 30 and exit sensor 40 in Fig. 1 and similarly captures a vehicle's contour, as the vehicle pulls into a parking space. The contours from the entry sensor 30 and the parking sensors 60 are compared to identify which vehicle has parked in which parking space. This enables the number and the location of the remaining parking spaces to be determined.

An important part of implementing this invention includes the ability to track each vehicle. Identical manufacturer and model vehicles are distinguished by the time of entry and present location of each vehicle. Even if multiple vehicles of the exact same manufacturer and model enter the parking facility 70 consecutively, they are each tracked and kept distinct. One method of tracking the vehicles also includes the use of ultrasonic sensors, or other transmitting and receiving technology. Vehicles are tracked as they pass such sensors located throughout the parking facility 70.

Tracking methods may also include the use of ground sensors of various technologies that detect the presence of a given vehicle (vehicle proximity sensors). These may include electromagnetic, loop coil, piezoelectric or optical technologies. The implementation of these sensors may be used to form a grid over the parking facility 70, where the location of any vehicle could be found by tracking the grid coordinates. Another method of tracking would employ tracking a transmitter that is located inside the vehicle and mapping the coordinates to the parking facility 70 layout. Yet another method of vehicle tracking is the Global Positioning System (GPS) and is described later as an alternate embodiment. The ultrasonic and vehicle proximity technologies represent the best mode for this invention because they are the easiest to implement at this time.

Fig. 3 demonstrates how the dynamics of the parking traffic are transmitted from the parking sensors 60 to the rest of the computerized parking facility management system. The computer 10 uses the output (A1-A5, A6-A10) from the parking sensors 60 to determine the vehicle parking in a given space. The computer 10 then updates variable message displays 50, strategically located throughout the parking facility 70, to notify motorists of vacant parking spaces in a specific section of the parking facility 70. The variable message displays 50 are mounted clearly in each section of the parking facility 70 and convey the location of vacant parking spaces using markings that uniquely label each space (A1 through A10) within the actual parking area. Without such labels the variable message displays 50 will simply show the total number of open spaces. As depicted at the top of Fig. 2 and Fig. 3, the motorist in the vehicle is guided to the nearest available parking spaces. Without notification from the variable message displays 50, the motorists will unnecessarily continue to drive throughout the parking facility 70 looking for an open space. As communication improvements continue with Internet-enabled personal organizers and mobile telephones, eventually motorists will be able to receive notification of available spaces through the display of these devices.

In Fig. 3, the System Interface 120 provides a simulation of the actual parking facility dynamics. It is a computer-generated environment and also used to provide control of and extract information from the computerized parking facility management system. A principle component of the System Interface 120 is a computer screen graphical parking replica 125 of a section of the parking facility 70 that shows the number of spaces, their physical layout, location and parking status. The location of the parking spaces are indicated by the arbitrary name 121 given to a section of the parking facility combined with the individual parking space label 122. In case all of the graphical parking spaces within the defined section are not within the computer screen view the total number of spaces within the section as well those spaces that are open is indicated by the summary label 123. The parking status symbol (+) 124 provides a graphical indication whether a particular space is occupied with a vehicle. With this invention, every space within a parking facility is unique because of its location. The section name 121 and parking location label 122 help to properly categorize and reference each space so that each vehicle in each space is further defined as unique.

The System Interface 120 also includes various menu options to control system functions, collect parking information and to configure the appearance of the environment. The System Interface 120 also provides various windows that support the system functions as well as display the results of requested information. Examples of the variability of the System Interface 120 are presented by observing Figs. 3,4,5,6,7,10 and 12.

It is important to note that a facility operator can readily view any parking section and even view several parking sections simultaneously through independent view windows within the System Interface 120. The scale of the graphical parking replica 125, the number of view windows and the size of the parking section determine how much of the parking section is visible within a view window. This is accomplished through the use of the "View Settings" function for either static or dynamic monitoring of the parking areas.

During static monitoring, dragging a computer pointer arrow along horizontal and vertical scroll bars allows manual positioning of any portion of the parking section that does not fit within the view window(s). A different parking section can also be viewed in any window through a manual invocation. During dynamic monitoring, the computer 10 automatically scrolls to reveal parking spaces that otherwise do not fit within the view window. Dynamic monitoring also automatically updates the view window(s) to show all parking sections in the entire parking facility 70. Static monitoring is used when facility operators need to quickly observe any desired section or parking space, otherwise dynamic viewing is chosen. In addition to updating the variable message displays 50 for the motorists, the parking status on the System Interface 120 is also updated in real-time for parking facility operators as changes actually occur in the parking facility 70. The capability to see the real-time parking status of an entire parking facility 70 through a single information source is provided with this invention and surpasses all prior art.

The System Interface 120 of Fig. 3 provides menu options to several functions of the computerized parking facility management system. The "Notification" function allows the facility

operator to receive notification when a vehicle in a target parking space vacates that parking space and when a vehicle remains in a target parking space for a specified period of time. Notification is also provided the next time a vehicle parks in a target parking space and when a target parking space remains vacant for a time specified by the facility operator. Additional information about the Notification function is outlined in the discussions on Fig. 6 and Fig. 7.

The "Archive" function stores a vehicle's statistics on the computer's 10 storage medium. The details of the Archive function are described in the discussion of Fig. 6. The "Search" function is described in greater detail in the discussions on Fig. 5. The "Theft Prevention" function is also described in greater detail in the discussions on Fig. 8, Fig. 9 and Fig. 10. The system can maintain a database of the number of vehicles that parked within the parking facility, their location, their parking start times and parking duration. The "Reports" function can then customize all the information in desired formats and statistical arrangements to conduct capacity planning, facility accounting and capacity trend analysis.

Fig. 4 describes another feature of the computerized parking facility management system, which is the Vehicle Identification 90. When the computer pointer arrow is used to select a (+) symbol within the graphical parking replica 125 that indicates an occupied space, the System Interface displays the vehicle statistics of the occupying vehicle. In addition to displaying the photographs taken by the digital camera as the vehicle entered the parking facility, the Vehicle Identification 90 also shows the date and time of entry into the parking facility 309, the date and time of parking 303, confirmation of the parking location 302, the parking space label 301, the parking status of the space 304, and time of the parking status inquiry 300.

If the target space has a special designation 305, such as time-limited, reserved or for disabled persons, that special designation is displayed. If the parking facility charges for parking, then the revenue generated since the vehicle has been parked 306 is also displayed. The charge rate 308 is included because some charge-for-park facilities charge a higher rate for premium spaces versus economy spaces. Airport parking is a typical example. Finally, the Vehicle Identification 90 form shows if the vehicle is being monitored against theft 307 by the Theft Prevention function, which will be described in the discussion of Fig. 8, Fig. 9 and Fig. 10.

The bottom of the Vehicle Identification 90 form shows six command buttons. The first button is "Notification", which allows the facility operator to get notification the moment the vehicle leaves the space or if the vehicle remains parked for a period of time, as defined by the facility operator. Thus the operator can be notified when the time for the time-limited space 305 has been exceeded. The second button is "Archive", which requests that the Vehicle Identification 90 information and the date and time of the vehicle's exit from the parking space and the parking facility be saved on the computer's storage medium, for indefinite retrievals. The third button is "E-Mail", which allows the Vehicle Identification 90 form to be e-mailed over the Internet or private computer network. The fourth button labeled "Fax" allows the information to be faxed. The fifth and sixth buttons are "Print" and "Close", which simply print or close the Vehicle Identification 90 form.

The result of the Vehicle Searching 100 function is depicted in Fig. 5. This function allows a parking facility operator to search an entire parking facility 70 for specific vehicles. Facility operators define their own search criteria, such as, "find all vehicles that have generated revenue of an arbitrary amount", " find all vehicles that parked between any two dates or times", " find all vehicles that parked in a particular area", " find all vehicles that parked in specially designated spaces (time-limited, disabled parking, visitor or reserved parking)", " find all vehicles of a specific manufacturer and model", " find all vehicles with a license plate from a specific state " or " find all vehicles with a license plate matching specific characters". A search can also be done based on combinations of criteria. By selecting the "Next" and "Last" buttons of the Search Results, a facility operator can scroll through all of the vehicles that meet the chosen "Search Criteria". Fig. 5 also indicates that the information can be printed, transmitted by fax or e-mail. The "Notification" button provides access to the Notification function and the "Archive" button requests that the vehicle statistics be saved after the vehicle exits the parking facility.

Optical Character Recognition (OCR) and License Plate Recognition (LPR) will support the Searching 100 feature by providing the conversion of the license plate photograph to computer-recognizable text. Components for these technologies are available from various vendors. By analyzing vehicle contours searches can be done to locate vehicles according to their manufacturer and model since the contour of a vehicle is a distinguishing feature.

The Define Notification 110 function in Fig. 6 defines and requests the information provided in the Notification Complete 111 function in Fig. 7. The Notification Complete 111 function informs a facility operator when a vehicle in a targeted parking space vacates that space or when a vehicle in a targeted space remains for a period of time as specified by the facility operator. Notification is also provided the next time a vehicle parks in a targeted parking space or when a targeted parking space remains vacant for a period of time as specified by the facility operator.

As shown by example in Fig. 6, the facility operator selects a space of interest within the graphical parking replica 125, choosing the open space X50 on the 3rd Level of the East Deck. In response, the System Interface completes the Define Notification 110 form with the chosen location as the "Notification Target". Any location selected with the computer pointer while the Define Notification 110 form remains open will become the "Notification Target". The button labeled "Identification" summons the Vehicle Identification 90 form (Fig. 4) with the associated vehicle statistics. This gives the facility operator access to that information for every occupied space, to help determine the type of Define Notification 110 to request. The lower portion of the "Notification Target" section is a list of specially defined parking spaces such as Reserved, Disabled, Time Limited, and No Parking. Completion of the Define Notification 110 form with a specially defined group requests a notification for each parking space in the group without requiring the facility operator to find each space separately and subsequently completing a separate Define Notification 110 form. This capability surpasses all prior art by allowing parking facility operators to get immediate notification and to view of all vehicles that park in restricted, reserved, time-limited, and disabled parking areas.

Any or all of the "Notification Options" in Fig. 6 can be chosen. With the "Screen Message" option, the Notification Complete 111 message box in Fig. 7 is displayed on the System Interface showing the time and date of the information and verification of the target location and type of watch (Time, Next Occupied, Next Open). The message box is accompanied by sound annunciation through the computer's 10 speaker. A separate screen message (Notification Complete 111) is displayed for each notification request whenever the controlling condition is satisfied. Fig. 6 also shows the "Printer", "E-mail", and "Fax" notification options which will allow the notification results to be printed, e-mailed, or faxed. "Archive" is another output option and will be described later.

A notification request can be based on time or parking space occupancy, as defined in the "Watch For..." section in Fig. 6. A time-based notification request is satisfied when the hours and minutes entered in the "Input Time" section expire, as long as the parking status (Open or Occupied) does not change. However, if the status changes during the time-based watch, it triggers completion of the watch, with a notification message that the time-based watch was interrupted by a change in parking status (not shown).

The "Next OCCUPIED" watch, depicted in the "Watch For..." section of Fig. 6, pertains to a space that is open when the notification request was defined. Fig. 7 shows the screen message for the completion of the Define Notification 110 requested in Fig. 6. When a vehicle parks in space X50, the parking sensor 65 detects its presence and notifies the computer 10. The computer 10 updates the display 50 in the parking section to exclude the availability of space X50. The computer 10 also updates the graphical parking replica 125 of the System Interface 120, by placing a parking status symbol (+) 124 in the X50 computer screen location.

After the computer 10 verifies that space X50 is in the database of the notification requests, it activates the chosen notification option, which in this case is "Screen Message". The title of the message box includes the date and time that the condition was satisfied. The photographs taken of the vehicle as it entered the parking facility are also shown. At this point, the notification is complete. The Notification Complete 111 message box also has further options to e-mail, print or fax the on screen information. Another option is to archive all information for the vehicle. A similar explanation applies to the definition and execution of a "Next OPEN" notification, which pertains to receiving notification when a parked vehicle vacates a target parking space.

The various functions of this system provide various ways of observing parking activity and the associated vehicles. Parking facility operators may need to document the observed activity or vehicles for future reference. Therefore the Archive function is accessible to the other functions (as shown in Fig. 4, Fig. 5, Fig. 6, Fig. 7, and Fig. 10) to save the vehicle statistics (including photographs) of any vehicle of interest. The archive will occur for the same parking spaces or vehicles that are the targets for those functions. Archive information can be referenced indefinitely, even long after the vehicle has departed the parking facility.

Archives can also be defined based on parking dates / times and parking occupancy. The date and time archives save the vehicle statistics of all vehicles that park in target parking locations

between any two dates and times. Additional options are to perform the archive only once or at multiple intervals of time (such as daily, weekly and monthly).

The occupancy archives save the vehicle statistics of an arbitrary number of vehicles that park in target parking locations, as defined by the facility operator. Additional options are to archive the first "N" number of vehicles and then stop archiving or continuously archive the most recent "N" vehicles, where "N" is an arbitrary number. With the latter choice, the earliest archives are continuously discarded and replaced by an equal number of new archives.

Once the date and time archives or occupancy archives are defined, the computerized parking facility management system will archive the vehicle information without any human intervention. This automatic response includes conditions that meet the facility operator's repeating and continuous archive selections.

Another component of the computerized parking facility management system is the Theft Prevention function. Among its innovative features is its capability to protect every vehicle within a parking facility, including those that do not have an individually installed vehicle deterrence system. The Theft Prevention function responds to an attempt to steal a vehicle by activating barriers to restrict removal of the vehicle. Furthermore, notifications of the attempted theft are provided directly to the owner of the vehicle, the police, the parking facility operators, the insurance company, and the company that tracks stolen vehicles (if applicable).

Although the following explanation features a parking garage, the Theft Prevention function is also applicable to an uncovered parking facility. Fig. 8 depicts a multiple-level parking facility 70 with sensors mounted over each parking space. As the owner of a vehicle with an entry/exit card 140 enters the parking facility 70, the owner passes the entry/exit card 140 through the card reader 150 located at the parking facility entrance. The entry/exit card 140 is about the size of a credit card and will register the vehicle for theft prevention protection at any parking facility 70 that is monitored by the computerized parking facility management system.

The entrance card reader 150 will also implement an alphanumeric keypad so those users entering the parking facility 70 can employ theft prevention even without an entry/exit card 140. Although vehicle protection is still provided, the computer 10 will not have the pertinent information to contact anyone but the facility operator and the police. Their information is the Standard Notification Information 132 for the facility and resides in the computer 10.

With the appropriate equipment, the tones from a mobile phone, an electronic smart-card, or the wireless signal from a personal digital organizer could also transmit the Theft Prevention Profile 130 instead of the entry/exit card 140 and reader 150. The entry/exit card 140 and reader 150 are presently the most prevalent technology and are presented in Fig. 8 and Fig. 9 for this reason. However, it must be noted that this invention will integrate with the alternate digital technologies, as they become more prevalent.

The exit card reader (not shown) will also include an alphanumeric keypad for the entry of a parking code. This will allow a motorist that invoked theft prevention but subsequently lost the

entry/exit card 140 to still remove their vehicle without incident. The system can still fully respond to the Theft Prevention Profile 130 since the information was captured at the entrance of the parking facility 70. The bottom of Fig. 8 shows the typical information that is transferred from the entry/exit card 140 to the Theft Prevention function. This information, called the Theft Prevention Profile 130, contains information that identifies the owner, methods to contact the owner, vehicle information and additional contacts to be notified if an attempt is made to steal the vehicle.

The transfer of this information into the computer 10 is the first part of the theft prevention registration. The vehicle parks on the second level, in the far right position as indicated by the vehicle with the dotted-line outline. Once the parking sensor 65 over that parking space detects the vehicle and notifies the computer 10 of the vehicle's parked location, the computer 10 associates the Theft Prevention Profile 130 with the vehicle contour and photographs captured at the entrance by the entry sensor 30 and the camera 20. At that time, the registration of the vehicle is complete and the monitoring of the vehicle against theft begins.

Any removal of the vehicle after registration is detected by the parking sensor 65, and reported to the computer 10. The computerized parking facility management system tracks each registered vehicle based on the information indicating when each vehicle entered the parking facility 70, the vehicle contour obtained from the entry sensor 30, and other sensors positioned throughout the parking facility 70 for vehicle tracking, as previously described.

Before the vehicle can be removed from the parking facility 70 without activating the theft prevention responses, the vehicle must be unregistered. In other words, the vehicle owner must use the entry/exit card 140 to inform the computer 10 that he is leaving the parking facility 70. This is done when the owner passes the entry/exit card 140 through the exit card reader (not shown) positioned before the exit of the parking facility 70. Signs (not shown) near the exit card reader remind the owner to use the entry/exit card 140 to remove the vehicle from registration before reaching the exit. As the owner complies, the vehicle is unregistered and can exit without incident.

Consider what happens in Fig. 9 when an attempt is made to steal a vehicle that is monitored by the Theft Prevention function. The parking sensor 65 detects the removal of the vehicle, informs the computer 10, and the system tracks the vehicle. The perpetrator will not be able to discontinue the registration of the vehicle without the entry/exit card, which is still in the owner's possession. An exit sensor 40 is positioned immediately past an exit card reader (not shown), but before the exit itself. When the exit sensor 40 detects that the still registered vehicle passed the exit card reader, it notifies the computer 10, which activates the theft prevention responses shown in Fig. 9.

The deterrence includes several responses. Physical barriers are activated to prevent the vehicle's exit. The barriers 170 in Fig. 9 are intended to deflate the tires of the stolen vehicle. There is also a barrier 170 on the entry side of the parking facility 70 in case the perpetrator tries to exit through the entrance. The type of barrier 170 shown will still allow vehicles to safely enter the parking facility 70 because of the direction of the spikes, which will only deflate the tires of an exiting vehicle. A striped barrier arm 175 is also lowered to reinforce to the perpetrator that their attempt to

steal the vehicle has been observed and also warns that the barriers are activated. The spiked barrier and the barrier arm are examples of providing a restriction to the removal of the vehicle but other methods, such as lowering a gate, would also suffice. The focus of this invention is the activation of the chosen method of vehicle restriction and not the design of the method itself.

The computerized parking facility management system has access to modems and computer networks to allow the Theft Prevention function to respond to the Theft Prevention Profile 130 in Fig. 8. Contact is made to the parking facility operators, local security and the vehicle owner, through their choice of communications (pager, mobile telephone, stationary phone, e-mail, or personal digital organizer). Telephone calls (automated voice or pre-recorded message) are also made to the nearest police station, the vehicle's tracking company (if applicable) and to the owner's automobile insurance agent, if the owner included this information in the Theft Prevention Profile.

In Fig. 9, theft notification is also sent to the System Interface 120, which displays the owner and vehicle information of the Theft Prevention Profile 130 in Fig. 8 as the Theft-In-Progress notification in Fig. 10. Also displayed is the vehicle's parked location when taken 320 as well as the vehicle's location 322 and the time/date 324 when the theft prevention responses were activated. This informs authorities where to begin the search to retrieve the vehicle. In addition to calling the police, the Theft Prevention function also faxes or e-mails Fig. 10 (including photographs) to the police. This rapid notification to the police will better ensure retention of the vehicle and possible capture of the perpetrator. Additional distributions can be made with the command buttons at the bottom of Fig. 10.

In Fig. 9, various cameras 190 positioned at the exits are activated in an attempt to capture the identity of the perpetrator. At the discretion of parking facility managers, the Theft Prevention function can broadcast an alarm 180 within designated areas of the parking facility 70. This will allow the annunciation to be restricted to the vicinity of the vehicle theft. This option will be determined in advance and executed when a theft is in progress.

User participation is optional with the Theft Prevention function. Thus any motorist can choose to invoke or forego the protection. This optional choice is a different approach from the related art which demands participation in order to even park in a protected facility. The choice of each motorist to invoke the Theft Prevention function through the entry/exit card or alternative technology better ensures acceptance by avoiding a forced change of the motorist's parking habits.

A primary limitation of related art is the dependence on controlled entries into and exits from the parking facility. Controlled / restricted entries impede the speed and volume of traffic and thus are not practical in situations such as street parking in a busy downtown area. None of the related art offers management of street parking because it is not feasible to restrict the entries and exits of streets.

Fig. 11 shows another implementation of this invention, using the previously described components and concepts. The parking facility managers will be those responsible for traffic control (city government and police). Sensors 60 monitor each parking space. As previously described, the method of vehicle detection may be transmitting/receiving sensors, vehicle proximity sensors, or the Global Positioning System (GPS) 200. The outputs from the sensors 60 are communicated through the

computer 10 and to the System Interface 120 for monitoring. In this depiction, overhead ultrasonic sensors 60 are used and the mounting supports incorporate parking meters. An enhancement for this implementation integrates the output of the parking meters into the computerized parking facility management system. This arrangement would immediately notify authorities when the time on the meter expired, by employing the notification capability as shown in Fig. 7. This is similar to the described time-based notification request. An additional enhancement for this implementation includes a digital camera 20 to capture the visual vehicle identities in order to support functions previously discussed within the System Interface 120. The camera 20 in Fig. 11 serves the same purpose as the camera 20 in Fig. 1.

Motorists in vehicles traveling on the main street can view the variable message displays 50 on the corners of the side street. These displays 50 indicate the number of available parking spaces along the entire street. Thus motorists looking for a place to park can avoid turning onto the street if the displays 50 indicate no available spaces. This will minimize the motorist's time and frustration as well as unnecessary traffic.

Vehicles are restricted from parking in the designated "No Parking" area so as to prevent traffic congestion and collisions with vehicles turning onto the side street. The sensor positioned to monitor this area will notify authorities of a parking violation. This provision will also help to reduce parking violations within restricted areas such as fire zones, truck loading areas and private driveways. The inset diagram of Fig. 11 shows the input to and output from the system computer 10.

The preferred embodiment uses sensors to track and detect the presence of a vehicle within a given space as shown in Fig. 3. An alternate embodiment of the computerized parking facility management system is shown in Fig. 12. With the advent of Global Positioning System (GPS) 200 technology, the location of a vehicle can be precisely detected and tracked. Thus a vehicle equipped with the necessary components can be located within the parking facility 70 as part of its unique vehicle identification. The motorist can also be directed to available parking spaces using the on screen display within the vehicle possessing the GPS. GPS components are available from various vendors. GPS technology will integrate very appropriately with the computerized parking facility management system because of the simultaneous tracking of multiple vehicles that GPS technology can provide. An example of this implementation is fleet management.

The GPS is a mobile positioning system that combines an antenna and receiver with a wireless communications interface. When integrated with a transceiver, the GPS 200 hardware uses radio or cellular networks to send vehicle position, speed, time and status, from any location, to a base unit. Using this GPS data, a base unit displays real-time position on a background map display. The mobile unit is hardwired to a terminal to display the vehicle's position to the motorist, superimposed on a background map. Software within the mobile unit calculates vehicle position from GPS 200 signals. Software within the base unit manages communication and vehicle tracking. Software components within the base unit and the mobile unit include an interface to mapping applications, whereby a map of the parking facility, similar to the graphical parking replica, can be viewed. The GPS 200

technology may eventually offer advantages over the preferred embodiment because of less equipment (fewer sensors and associated equipment required). The invention functions would be as described. However, at this time, the GPS 200 is not the primary embodiment because of the insufficient number of vehicles with such positioning systems.

Parking revenue control within charge-for-parking facilities is a major effort in the parking industry. Parking revenue control includes the calculation of fees, collection of fees, revenue accounting, and the detection of parking violators. Because of its importance this invention does provides integration with revenue control efforts. An integration link between the computerized parking facility management system and parking revenue control is an electronic parking meter. An electronic parking meter is capable of providing a distinct electrical signal upon the expiration of time on the meter. That activation signal, or the absence of it, is transmitted to the system computer for processing and used to provide access to the functions of this invention.

Parking facility operators can receive immediate notification of all parking meters with expired time as described for Fig. 11. But more importantly the operators can see the associated vehicle, its location and vehicle statistics through the System Interface. This capability is equivalent to the Notification Complete 111 function based on time expiration and would be similar to Fig. 7 but the "Met Condition" information would indicate "Meter Expired". Once the parking revenue control effort is integrated into the computerized parking facility management system, the on-screen notification can then be printed, faxed, e-mailed, or archived through the command button selection.

The period between the expiration of time on the meter and the observance of the expired meter by a parking attendant is typically unknown. Often a motorist is charged for the expired meter time through the issuance of a fine. This is usually done because the revenue lost since the meter expired can not be computed because the associated time period is unknown. The penalty amount may be well over or under what the cost would be if the time period in question were known. This invention allows the proper parking charge to be determined despite the expiration of the meter. The Vehicle Identification 90 function shown in Fig. 4 will reveal the vehicle identities and the present accumulated revenue 306. The expiration of the meter time does not affect the independent ability of the system to determine the accumulated revenue 306 because the system uses the time 303 since detecting the parking of the vehicle and the charge rate 308. Documentation of the revenue owed at any point in time may be archived or transmitted using the command buttons.

Many parking revenue operations lose money because of inadequate accounting. The money earned is either not reported in a timely manner or not reported accurately. The computer screen of the System Interface shows the menu option "Reports". The Reports function allows parking facility managers to get reports of the revenue for various time periods as well as for various locations (named sections) of the facility. This information is available because the system accounts for the revenue accumulated by each vehicle that parks in the facility as well as the name given to the section of the facility where each vehicle parks. Even after the vehicle exits the facility the revenue charged to that vehicle is stored in a database. Managers can obtain reports by manual requests or inform the system

to send periodic reports automatically by e-mail or faxed to designated persons.

The Notification function can also determine when a motorist parks but does not pay. The system detects and identifies a vehicle when it enters the parking space as shown in Fig. 7. When the prolonged signal from an electronic parking meter continues to indicate that no payment has been made, the Notification 111 function will inform facility operators by displaying an on screen message similar to Fig. 7. The "Met Condition" information would indicate "No Payment". The Archive function can store the documentation for later retrieval or the information can be printed or transmitted by e-mail or fax.

The search function can support revenue control with the inclusion of search criteria to find and display the identities and locations of all parked vehicles with expired meters. As similarly shown in Fig. 5, this information can then be printed, archived for future retrieval, and transmitted by e-mail or fax.

As previously described, the Theft Prevention function provides various communications to notify selected persons, activation of cameras to document attempts to drive a vehicle through the exit of the parking facility as well as various alarms and barriers. These features can also be used to capture the identities and impede the exit of a vehicle whose driver attempts to exit the facility without paying. The appropriate persons (parking managers, parking security) can also be contacted through one of the communication options. An indication from the parking meter that a motorists has not paid coupled with the vehicle tracking and vehicle identification abilities of this invention will allow the system to automatically detect violators to enact the predetermined responses.

Many charge-for-park facilities use tickets instead of parking meters to control the collection of revenue. The ticket is time-stamped, issued to a motorist upon entry into the facility and collected upon exiting to determine the parking duration and associated charge. The loss of a parking ticket results in overcharges, undercharges, and disputes. Parking operators conduct manual, time-consuming, and costly daily inventory of all vehicles in the parking facility to document a vehicle's presence at a particular date and time, to support the cost charged to a disputing motorist who claims a lost ticket and a lesser parking duration.

This invention automatically performs a continuous inventory of all vehicles within the parking facility by identifying and documenting the presence of a vehicle upon entry into the facility. Thus the time and associated costs of manual inventories are eliminated. Furthermore, as shown in Fig. 4, the system provides a continuous calculation of the parking fee 306 with documentation of the vehicle's entry 309 into the facility. Thus this system not only reduces the dependence on tickets but also provides the documentation to resolve disputes regarding the entry time and parking duration. If required, the parking facility operator can print the content of Fig. 4 to validate the charge to the motorist. The information can also be archived for later retrieval and transmission even long after the vehicle has exited the facility.

It is to be understood that the present invention is not limited to the described embodiments, but encompasses any and all embodiments within the scope of the following claims.

## CLAIMS

I claim:

1. A computerized parking facility management system for the operation and management of a parking facility. A parking facility is any area designated for vehicle parking and includes parking garages, parking lots, charge-for-parking, no-charge parking and street parking. The system comprises:

the capture, display, and computer processing of the parking activities and identities of vehicles that enter said parking facility;

a means of uniquely identifying each vehicle throughout said parking facility; and

a means for detecting the presence and the absence of a vehicle throughout said parking facility.

2. The system according to claim 1, wherein said means of uniquely identifying each vehicle throughout said parking facility comprises characterizing and comparing the contour of the vehicle.

3. The system according to claim 1, wherein said means of uniquely identifying each vehicle throughout said parking facility and said means of detecting the presence and absence of a vehicle throughout said parking facility comprises global positioning system technology.

4. The system according to claim 1, wherein said means of uniquely identifying each vehicle throughout said parking facility comprises the digital photographic capture of a vehicle and the vehicle license plate and the integration of the photographs with said system.

5. The system according to claim 1, wherein said means for detecting the presence and the absence of a vehicle throughout said parking facility comprises the use of ultrasonic technology, transmitting / receiving sensor technology and vehicle proximity sensor technology.

6. The system according to claim 1, wherein a license plate photograph is converted into computer-recognizable text using technologies comprising optical character recognition and license plate recognition, whereby the license plate identification can be processed by the functions of said system.

7. The system according to claim 1, wherein owner and vehicle information are obtained from an electronic device or data storage media comprising:

the owner's name, address, telephone number(s), e-mail address, insurance agent, vehicle tracking company information for reporting stolen vehicles; and

the vehicle's vehicle identification number (VIN), manufacturer, model, year, state license, license plate number and color,

whereby said system automatically establishes immediate and direct contact and disseminates vehicle identity information in the event of an attempted vehicle theft.

8. The system according to claim 1, wherein collective vehicle theft deterrence is provided for any number of vehicles during an unauthorized attempt to remove a vehicle from said parking facility by means

comprising: the activation of alarms, activation of cameras and activation of barriers intended to prevent the removal of the vehicle from said parking facility, the dissemination of the vehicle's identities, notification to police, notification to the vehicle owner, and the capability of notifying other designated persons with interest in the theft prevention of the vehicle.

9. The system according to claim 1, wherein said system communicates with external entities through methods comprising facsimile, e-mail, the Internet, computer networks, telephone, modem, mobile telephone, personal digital organizer, pager and printer, whereby said system facilitates the communication of vehicle identities and parking facility activities to and from external entities.

10. The system according to claim 1, wherein information is captured and communicated that reveals the identification of a vehicle parked within said parking facility, comprising:

the time and date the vehicle entered said parking facility;

the time and date of exit if the vehicle has exited said parking facility;

the time and date the vehicle entered and exited the parking space or parked condition;

the location of the vehicle;

vehicle identities such as photograph of the vehicle and of the vehicle's license plate;

the present parking revenue and charge rate if the parking facility charges for parking;

an indication whether the parking location has a special designation such as time-limited, intended for disabled persons, reserved or restricted;

an indication whether the vehicle is being monitored for protection against theft; and

the means to view, print, transmit, store and retrieve the aforementioned information.

11. The system according to claim 1, wherein parking facility information is computer processed to search for a vehicle parked within said parking facility and the results communicated, comprising:

the search criteria for the vehicle;

the identities of the vehicle;

the location of the vehicle;

the date and time that the vehicle parked;

the vehicle's statistics / documentation of the vehicle's presence, identities, and activities;

a feature that allows an advance through the selection of all vehicles that meet the criteria including all aforementioned information; and

the means to view, print, transmit, store and retrieve the aforementioned information.

12. The system according to claim 1, wherein said system detects and provides automatic notification when a parked vehicle vacates a space, when a parked vehicle remains in a space for a designated period of time, when a vacant space becomes occupied with a vehicle, and when a space remains vacant for a designated period of time.

13. The system according to claim 1, wherein said system displays, disseminates, archives, and

computer processes a vehicle's identities, location and statistics based on defined time intervals of parking activity, based on a defined number of parking space occupancies, based on unauthorized vehicle removal, based on parking in a restricted area, and based on manual invocation of system functions.

14. The system according to claim 1, wherein the manufacturer and model of a vehicle within said parking facility is determined by comparing the vehicle's contour with contour data that serves as a template of a known vehicle.

15. The system according to claim 1, wherein one or more functions of said system is integrated with parking revenue control operations including the calculation of fees, collection of fees, revenue accounting, and the detection of parking violators.

16. A method involving the operation and management of said parking facility through a computerized environment comprising the steps of:

providing a graphical simulation of the actual parking dynamics of said parking facility, viewable in single or multiple windows, representing the spaces and their location within said parking facility, and an indication as to whether the spaces contain a vehicle;

identifying, displaying, and the computer processing of the identities, location, and statistics of a vehicle that has entered or exited a parked condition, a parking space, or said parking facility.

17. A system involving the operation and management of said parking facility comprising:

a means of identifying and managing parking space availability by detecting the presence and absence of a vehicle within parking spaces; and

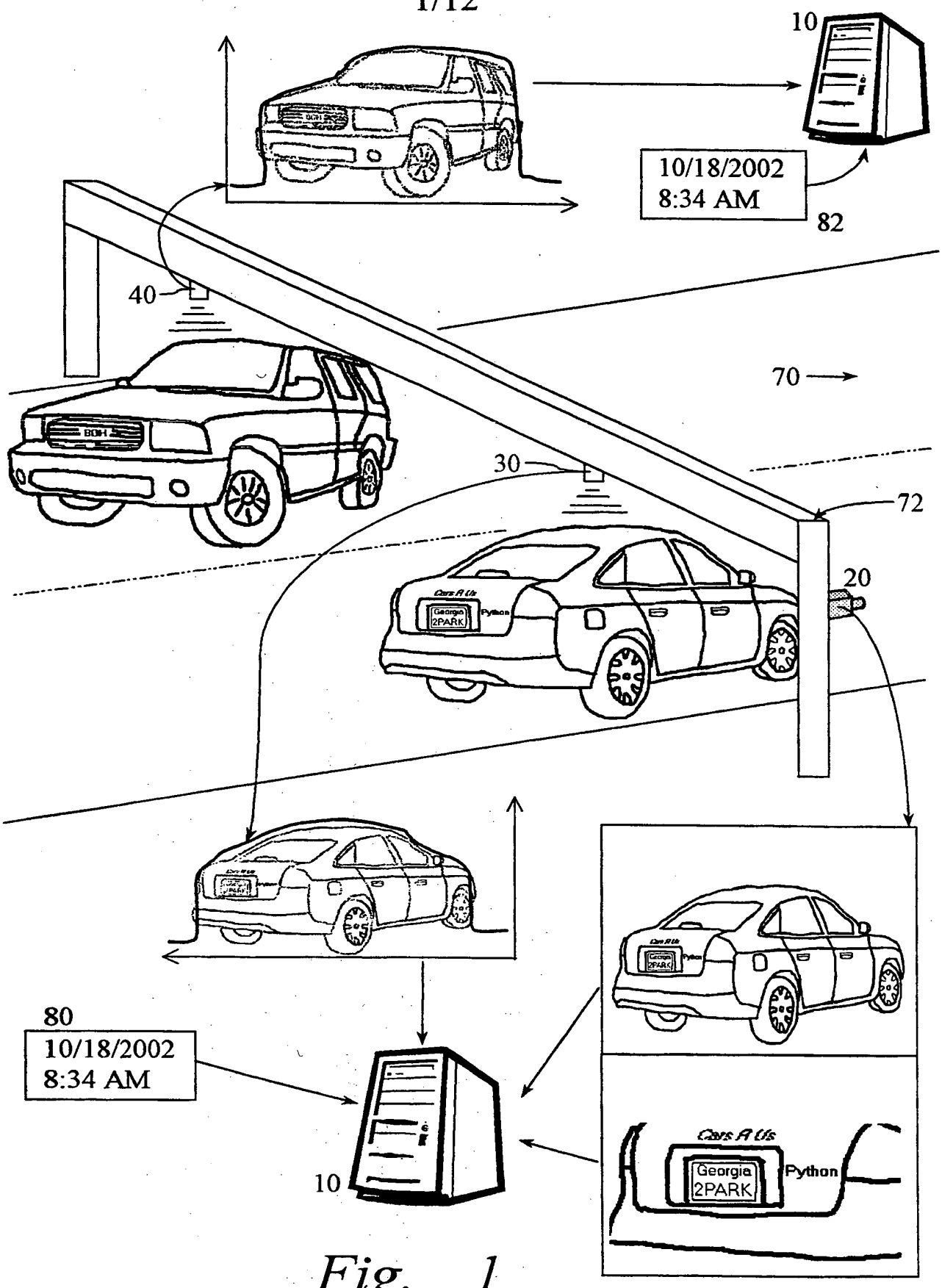
communicating the availability of the parking spaces within said parking facility through variable message displays.

18. The system according to claim 17, wherein said means of identifying and managing parking space availability by detecting the presence and absence of a vehicle within parking spaces comprises transmitting / receiving sensor technology and vehicle proximity technology.

19. The system according to claim 17, wherein said means of identifying and managing parking space availability by detecting the presence and absence of a vehicle within parking spaces comprises characterizing a vehicle's contour and the comparison of vehicle contours to determine vehicle location.

20. The system according to claim 17, wherein said means of identifying and managing parking space availability by detecting the presence and absence of a vehicle within parking spaces comprises the global positioning system to determine vehicle location.

21. The system according to claim 17, wherein vehicle theft deterrence can be provided to any number of vehicles within said parking facility through the automatic determination of a vehicle's presence by said system.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Cars A Us
Georgia
2PARK
Python

*Fig. 1*

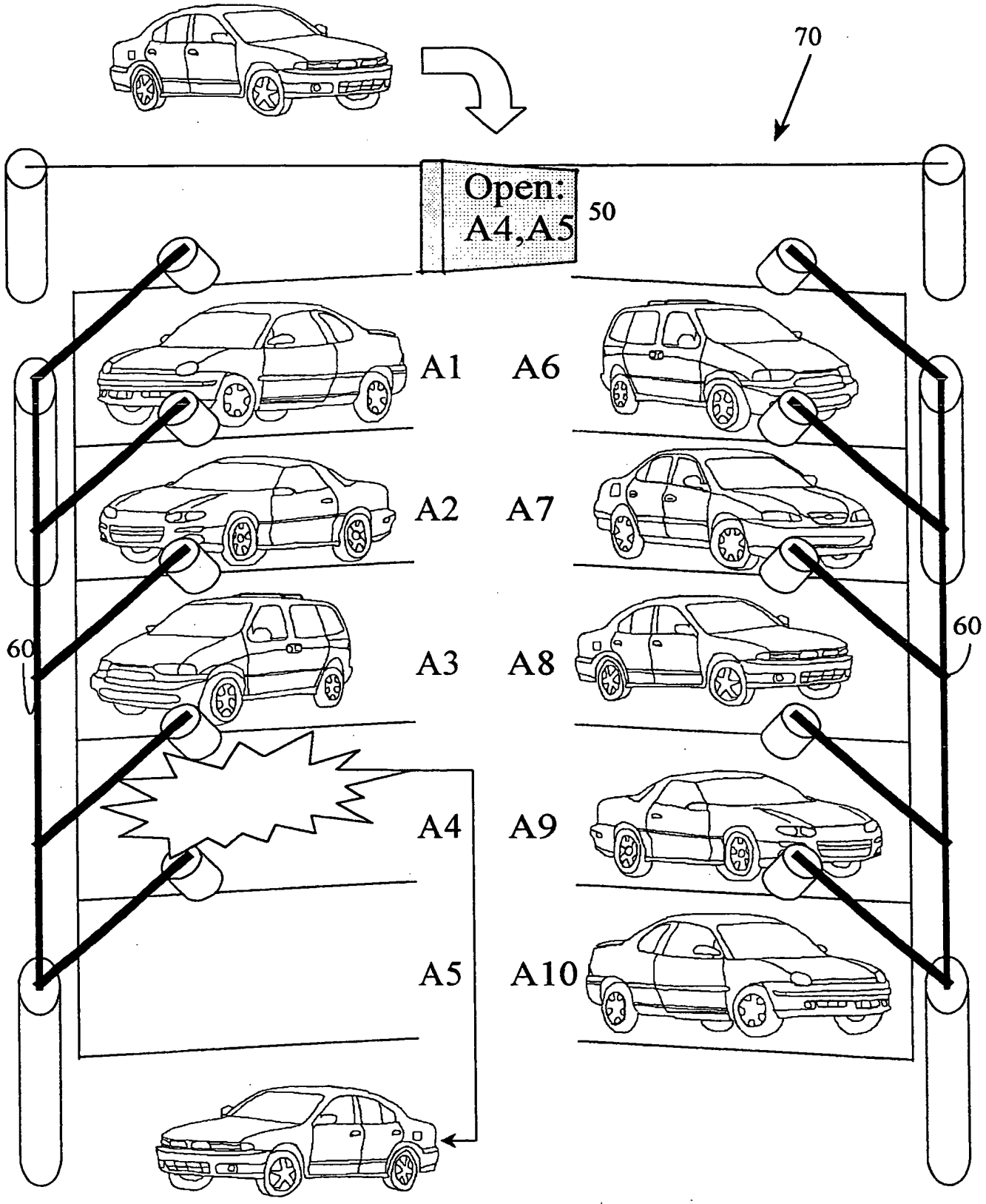
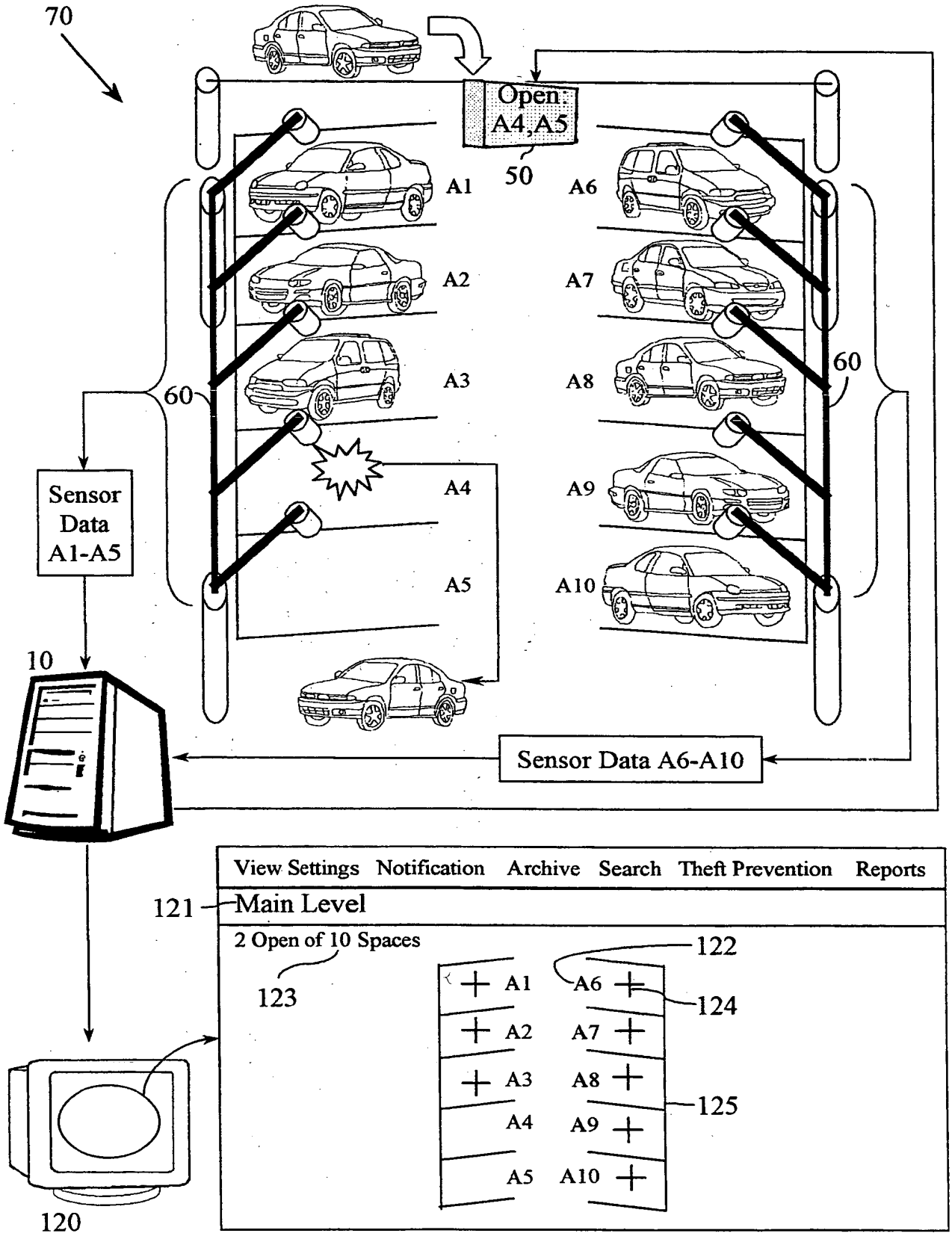



*Fig. 2*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A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
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60
Sensor
Data
A1-A5
10
Sensor Data A6-A10
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122
124
125
120

*Fig. 3*

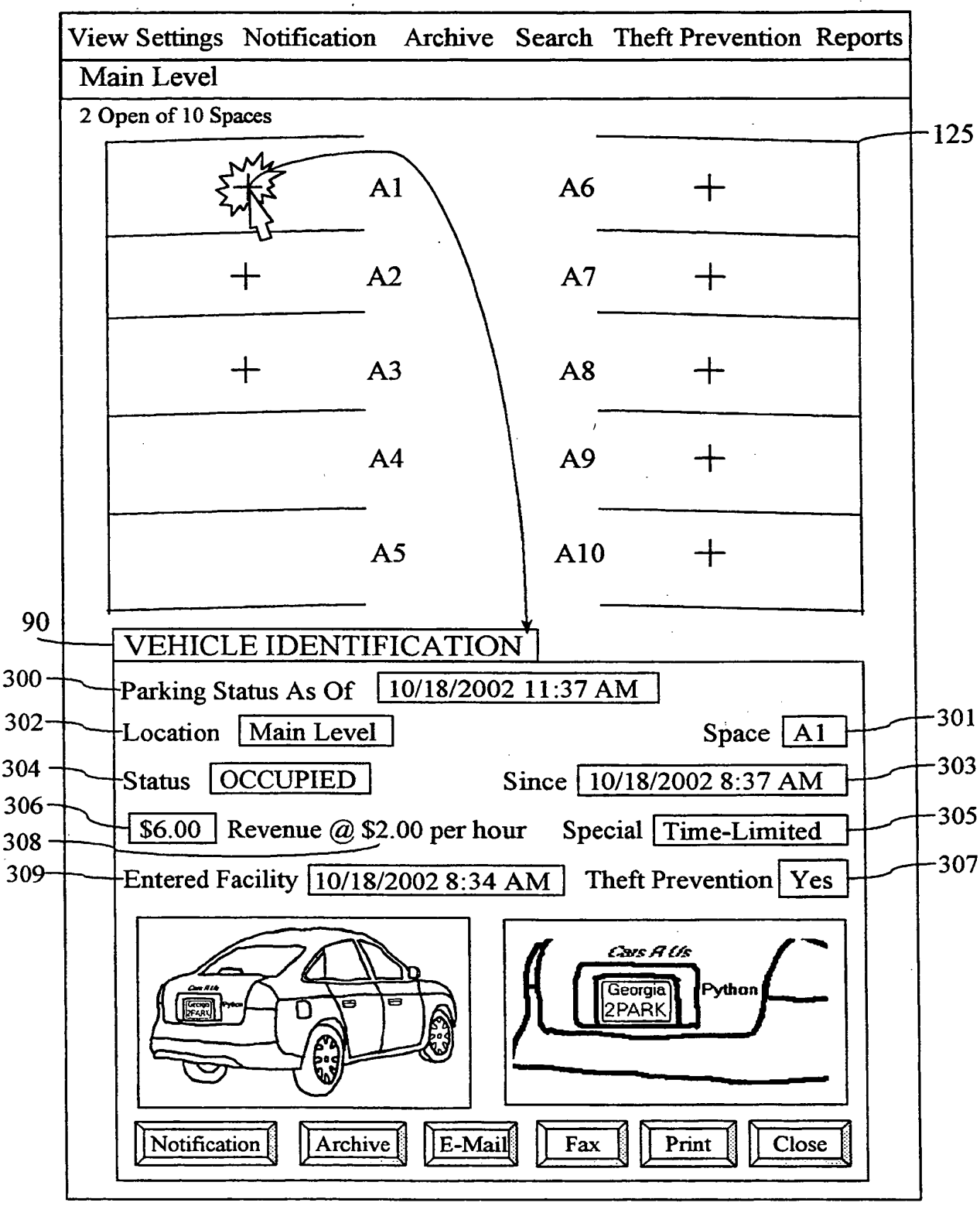
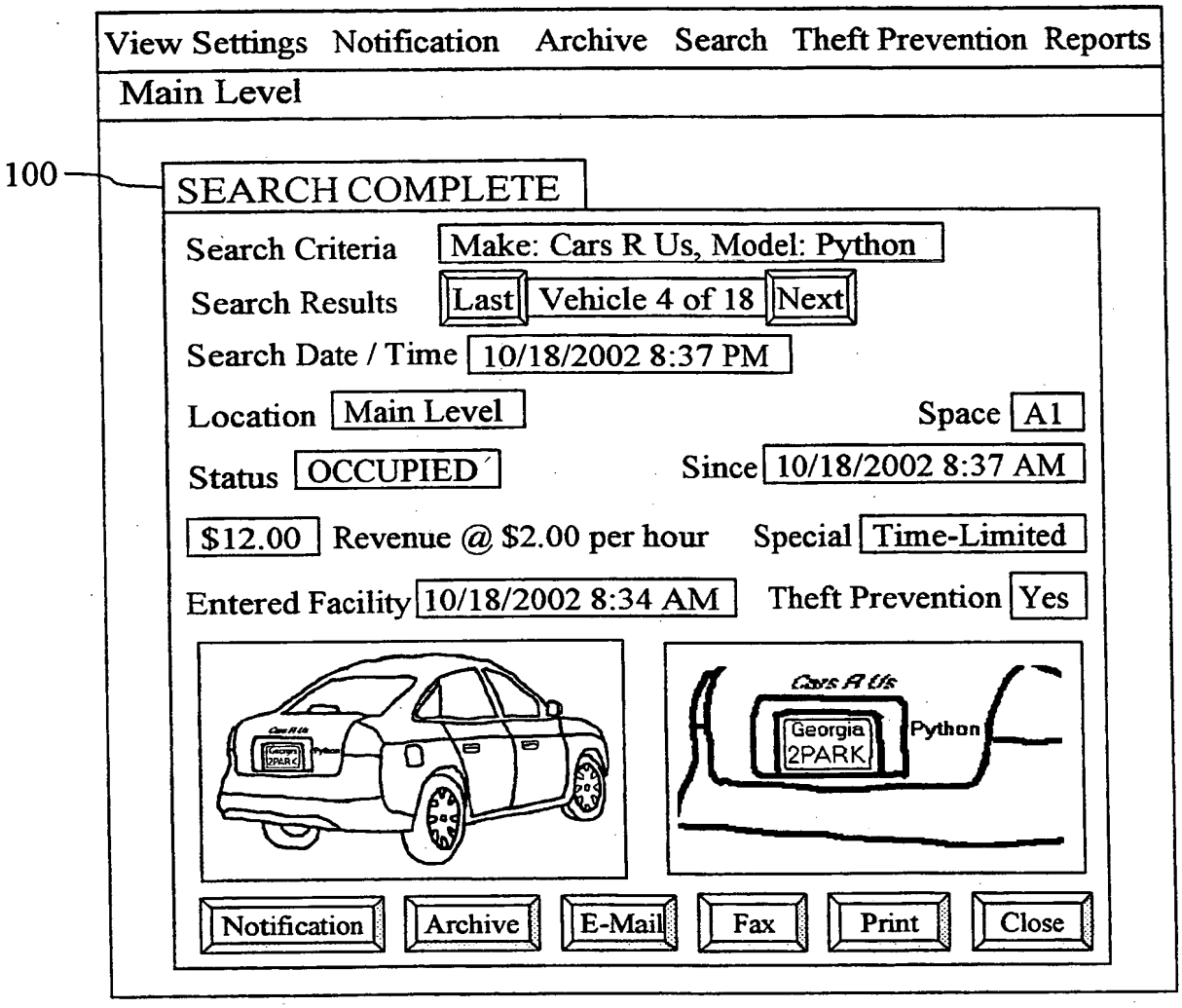



*Fig. 4*


View Settings Notification Archive Search Theft Prevention Reports
Main Level
100
SEARCH COMPLETE
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Make: Cars R Us, Model: Python
Search Results
Last
Vehicle 4 of 18
Next
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10/18/2002 8:37 PM
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Special
Time-Limited
Entered Facility
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Print
Close

*Fig. 5*

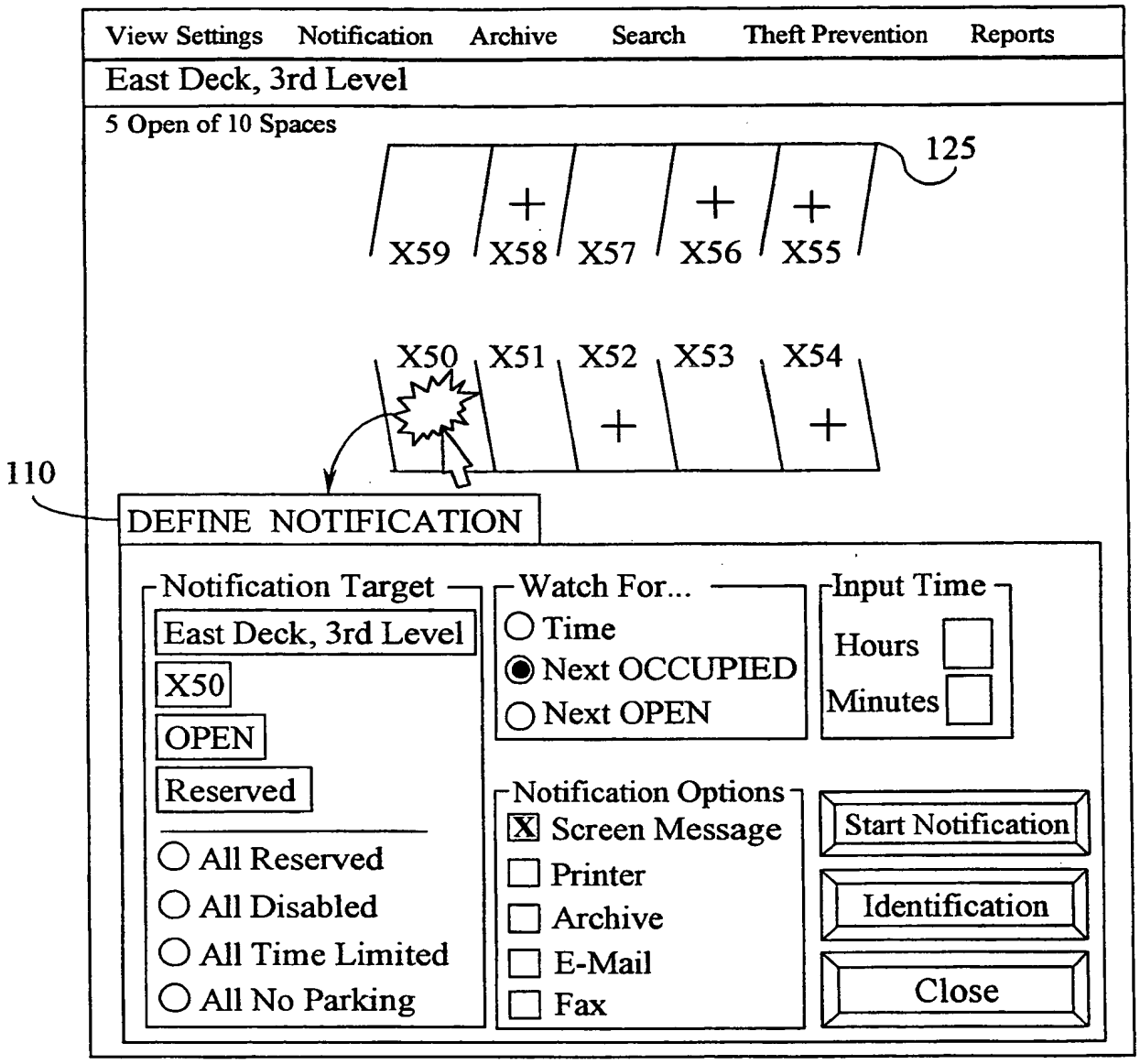



*Fig. 6*

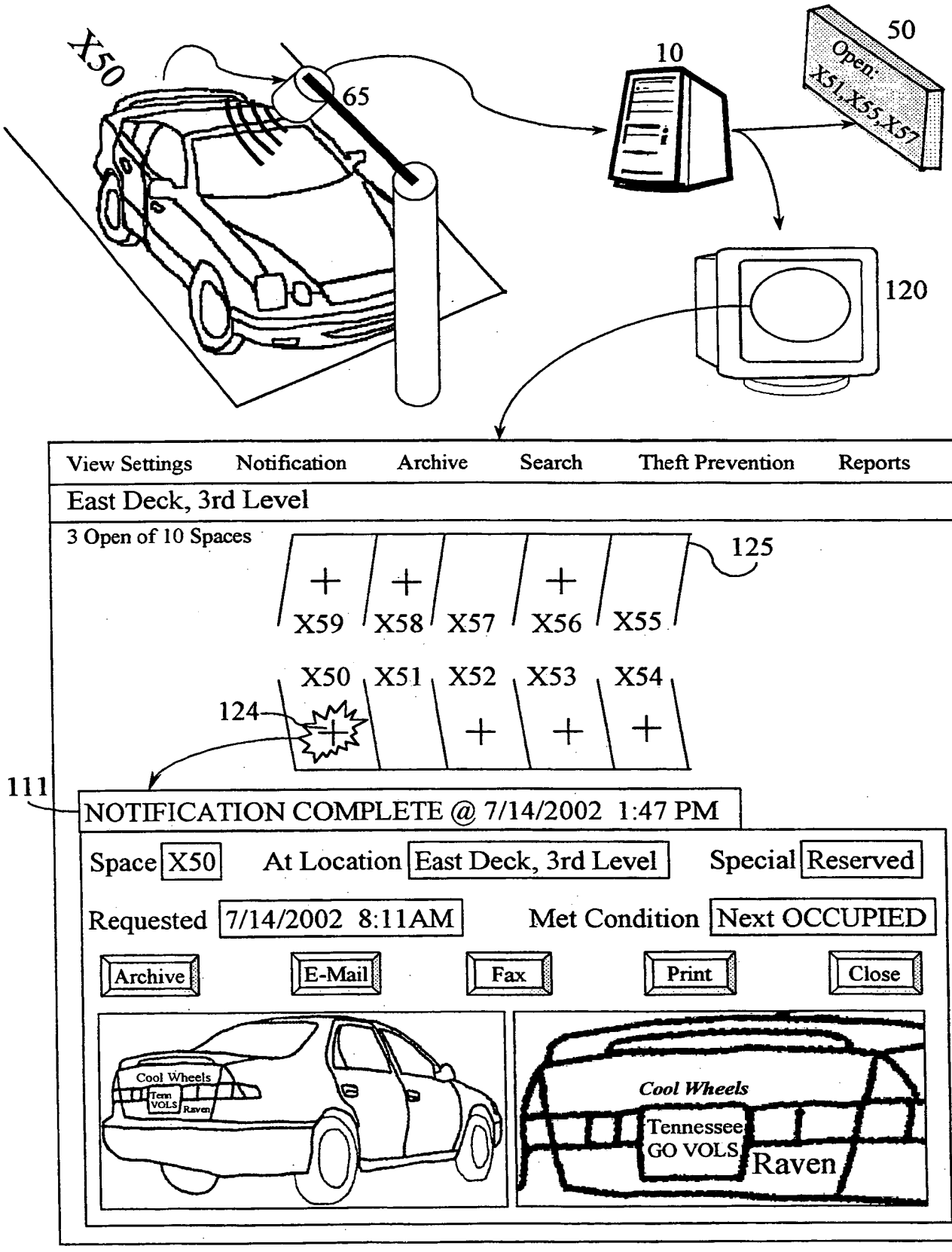
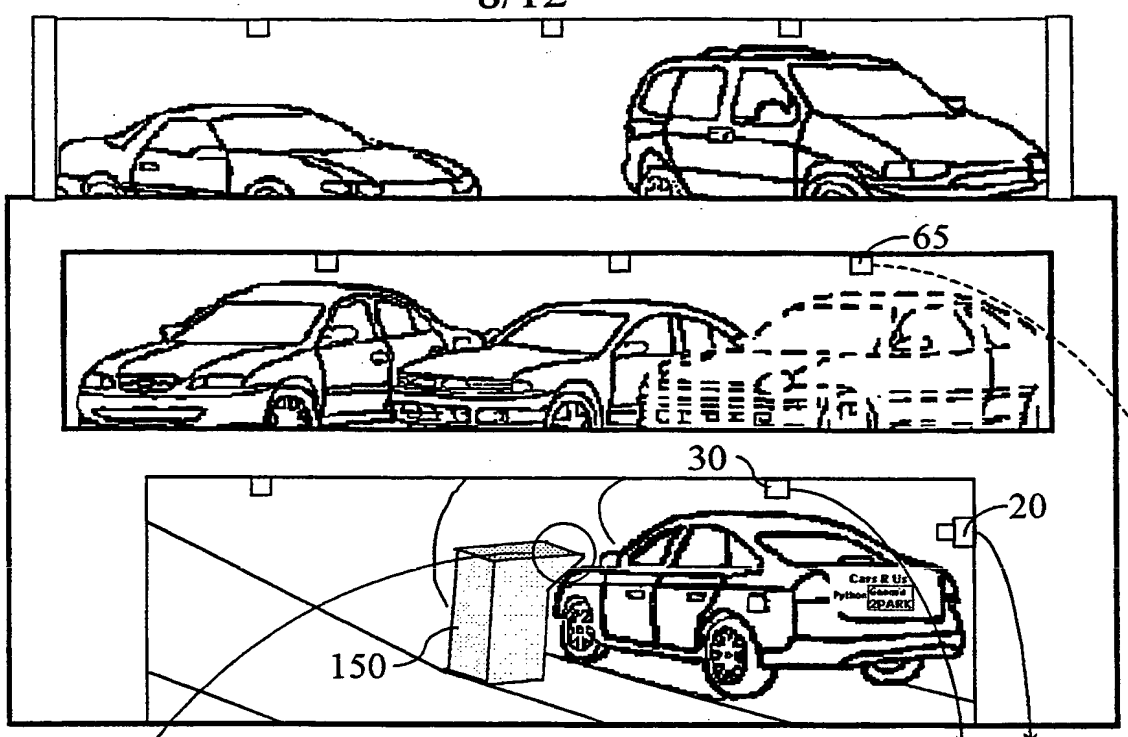



*Fig. 7*




**Standard Notification Information** 132

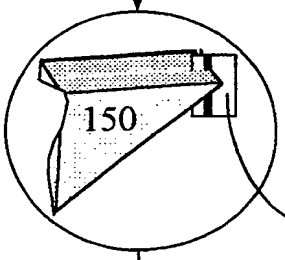
- Phone numbers of parking facility operators
- Police telephone number

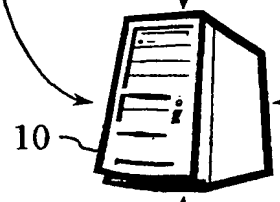
**Before Parking**

- Time & Date Into Parking Facility
- Digital Photos
- Vehicle Contour

**After Parking**

- Time & Date Parked
- Parking Location
- Time & Date Of Removal




130

**Theft Prevention Profile**

Card Number: GA0215028

| Owner Information | Vehicle Information |
|---|---|
| Owner Name: Brett Hall | VIN: KB2IJG0559WB8J |
| Address: 384 Patent Street | Vehicle Make/Model/Year: Cars R Us / Python / 2002 |
| City/State/Zip: Somewhere, US 048583 | License: Georgia, 2PARK |
| Primary Phone: 565-123-7954 | Vehicle Color: White |
| Secondary Phone: 565-495-1862 | Phone to Activate Tracking Transmitter:800-489-1278 |
| E-Mail: bhall@bhalltechnologies.com | Insurance / Agent: ACME / Joe Jones / 565-778-0001 |

*Fig. 8*

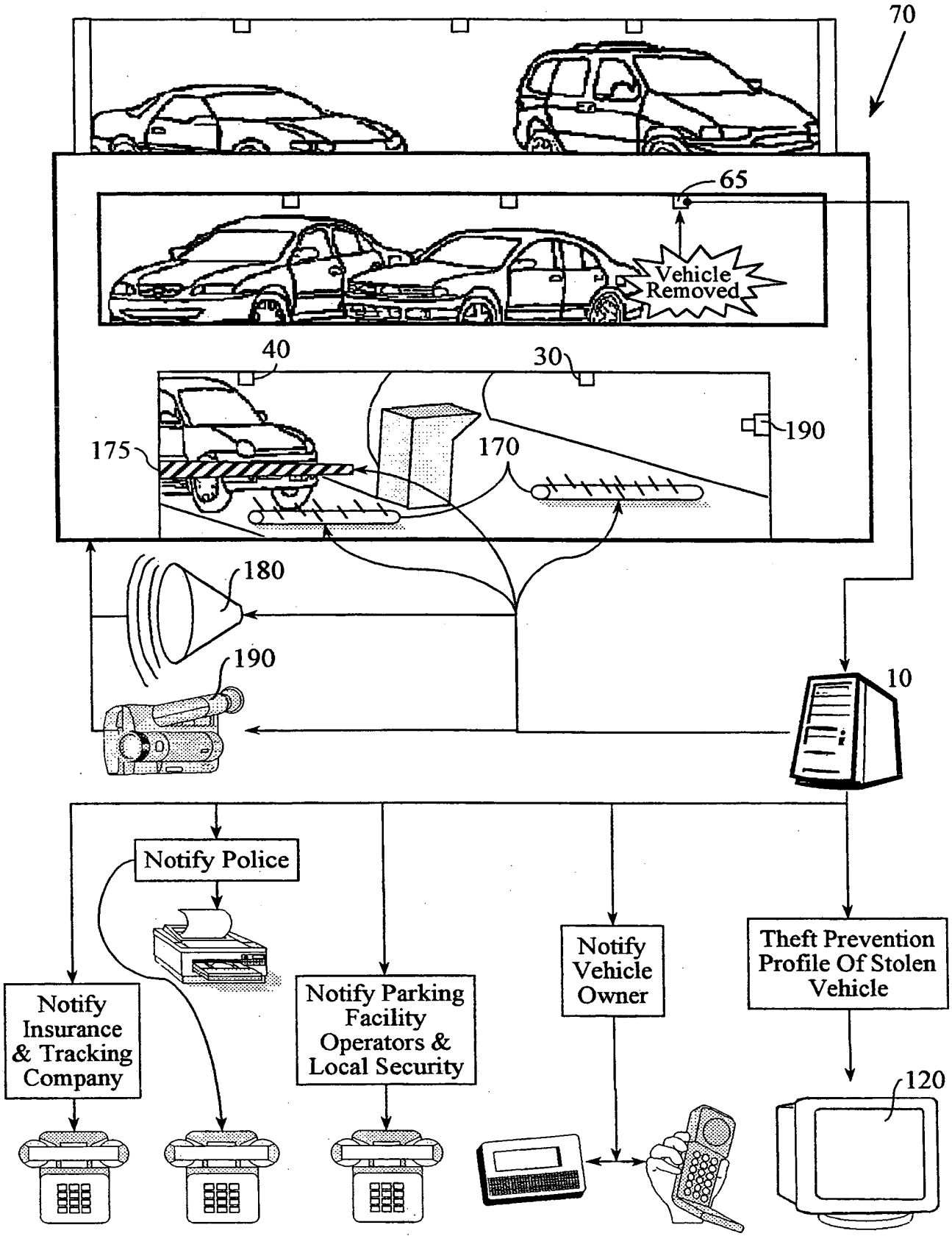

70
65
Vehicle Removed
40
30
175
170
190
180
190
10
Notify Police
Notify Insurance & Tracking Company
Notify Parking Facility Operators & Local Security
Notify Vehicle Owner
Theft Prevention Profile Of Stolen Vehicle
120

*Fig. 9*

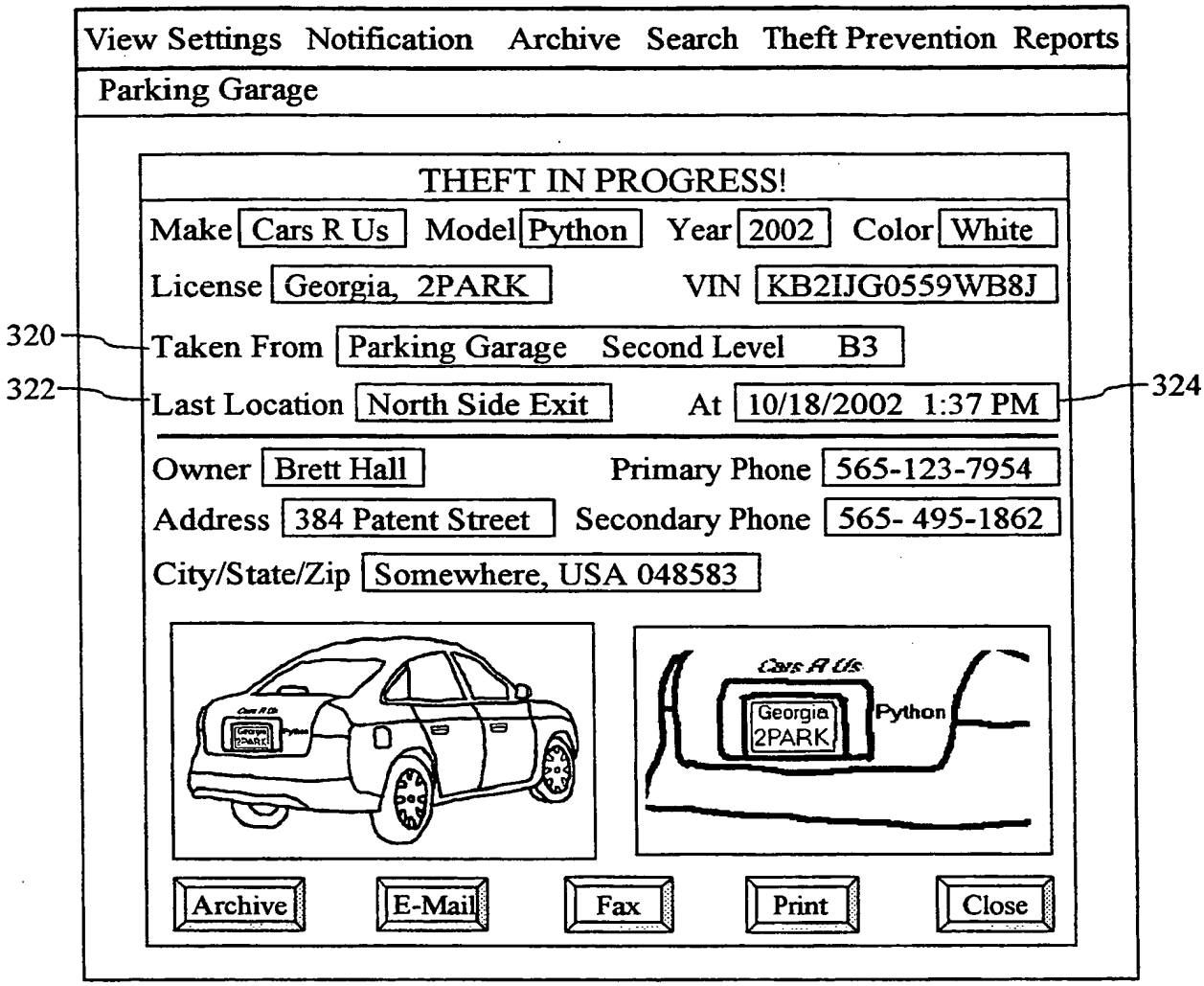
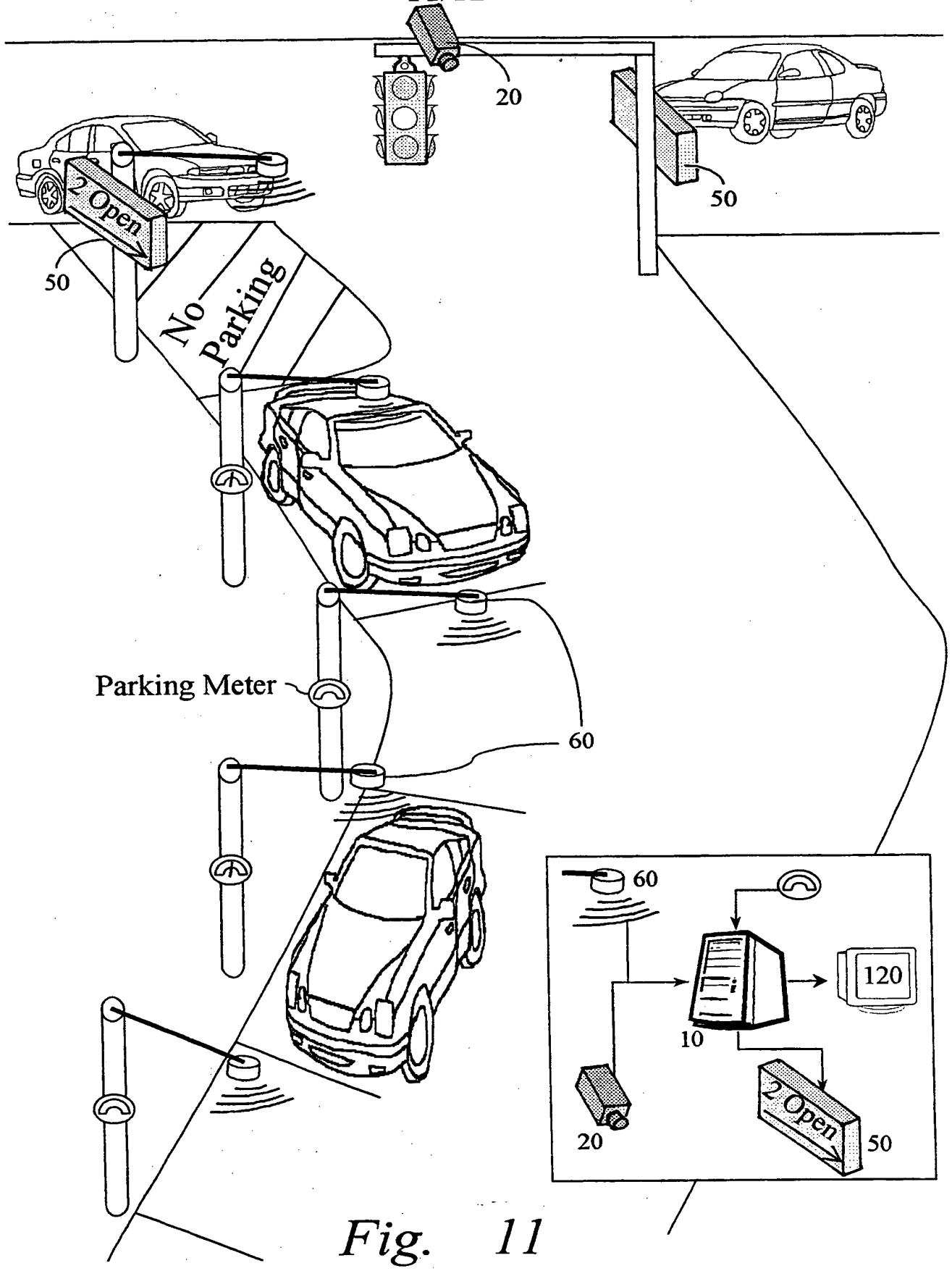



*Fig. 10*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50
2 Open
50
No Parking
Parking Meter
60
60
120
10
20
2 Open
50

*Fig. 11*

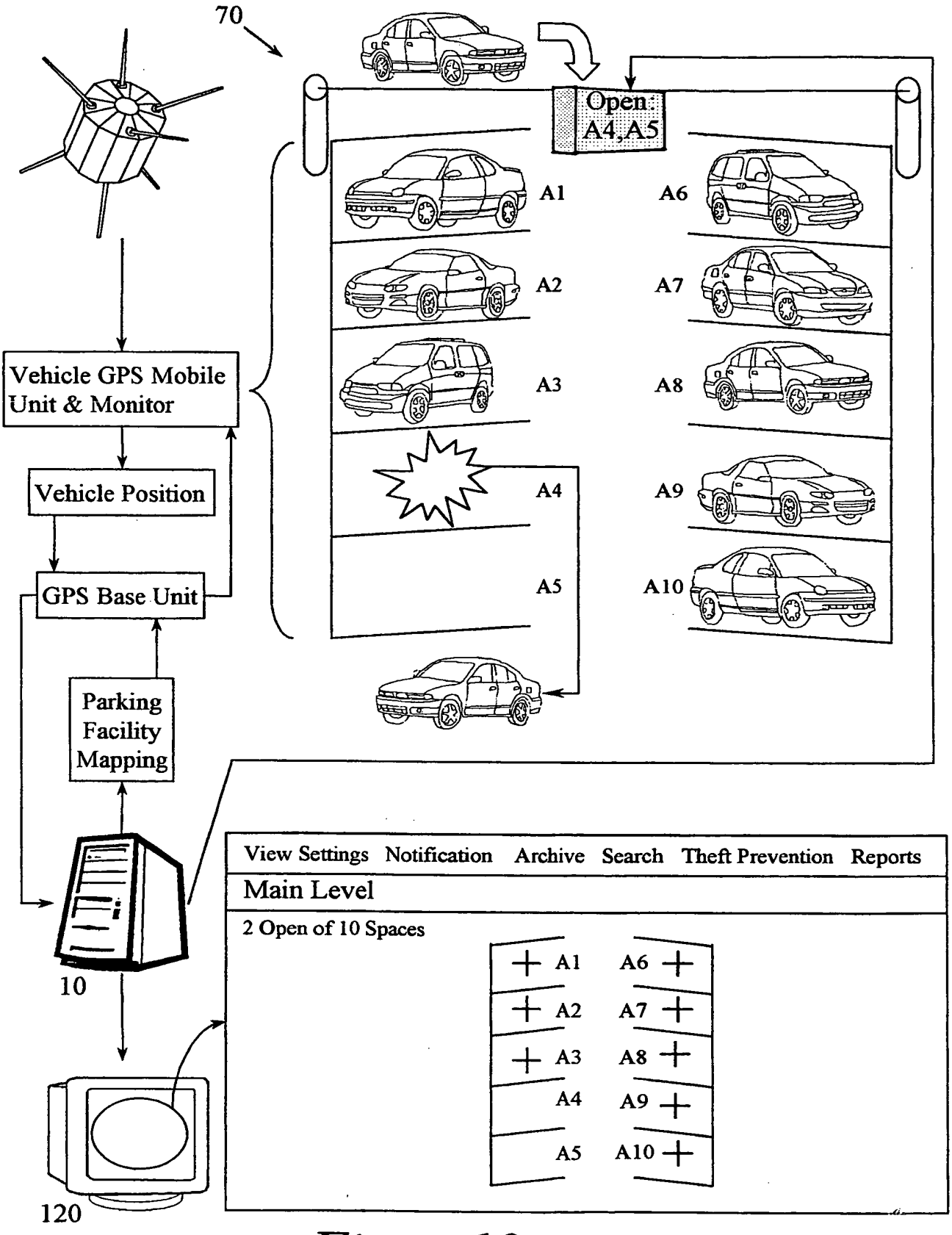


*Fig. 12*

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/02737

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) :B60Q 1/48
US CL :340/932.2, 905, 933; 464/467, 556, 424.01
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 340/932.2, 905, 933; 464/467, 556, 424.01

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, EAST, WEST

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>---<br>Y | US 4,603,390A (MEHDIPOUR et al.) 29 July 1986, col. 1, lines 62-68 and col. 2, lines 1-68, and col. 3, lines 1-39 | 1-4, 6-17, 19-21<br>---<br>1-21 |
| X<br>---<br>Y | US 5,432,508A (JACKSON) 11 July 1995, col. 3, lines 57-68 and col.4, lines 1-68 and col. 5, lines 1-65 | 5, 8<br>---<br>1-21 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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|---|---|
| Date of the actual completion of the international search<br>19 MAY 2000 | Date of mailing of the international search report<br>09 JUN 2000 |
| Name and mailing address of the ISA/US<br>Commissioner of Patents and Trademarks<br>Box PCT<br>Washington, D.C. 20231<br>Facsimile No. (703) 305-3230 | Authorized officer<br>TAI T. NGUYEN<br>Telephone No. (703) 305-4717 |

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